Claims

[1] 1. A liquid-filled lens driver for receiving a lens driver control signal from an image signal processor and driving a liquid-filled lens, comprising:
an input/output interface unit for exchanging the lens driver control signal and status information of the liquid-filled lens with the image signal processor according to a certain signal transmission protocol;
a system clock generation unit for generating a system clock;
a high voltage generation unit for generating high voltage, which can drive the liquid-filled lens, using low voltage of a battery of a mobile information terminal;
a reference/bias voltage generation unit for providing reference voltage and bias voltage for operating the liquid-filled lens driver;
a drive signal generation unit for generating a final drive signal for the liquid-filled lens by boosting an output waveform to a high voltage level generated in the high voltage generation unit after generating the output waveform for driving the liquid-filled lens; and
a control unit for controlling the function units for driving the liquid-filled lens.

[2] 2. The liquid-filled lens driver according to claim 1, wherein the liquid-filled lens driver is provided to each liquid-filled lens, and is provided with a unique Identification (ID).

[3] 3. The liquid-filled lens driver according to claim 1, wherein the exchange of the lens driver control signal and the status information of the liquid-filled lens in the input/output interface unit is performed by a 2-wire serial communication method using:
a clock signal wire for exchanging a control clock signal that controls the exchange of image information; and
a data signal wire for exchanging data related to the image information and determining power operation status of the liquid filled lens driver.

[4] 4. The liquid-filled lens driver according to claim 1, wherein the exchange of the lens driver control signal and the status information of the liquid-filled lens in the input/output interface unit is performed by a 3-wire serial communication method using:
a clock signal wire for exchanging a control clock signal that controls the exchange of image information;

a data signal wire for exchanging data related to the image information; and
a power control signal wire for determining power operation status of the liquid-filled lens driver.

[5] 5. The liquid-filled lens driver according to claim 3 or 4, wherein the determination of the power operation status of the liquid-filled lens driver is performed in such a way as to stop operation of the liquid-filled lens driver by disabling all reference voltage and bias voltage of the liquid-filled lens driver and turning off the system clock generation unit when a power-off mode signal is received.

[6] 6. The liquid-filled lens driver according to claim 3 or 4, wherein the determination of the power operation status of the liquid-filled lens driver is performed in such a way as to normally operate the liquid-filled lens driver by enabling all reference voltage and bias voltage of the liquid-filled lens driver and turning on the system clock generation unit when a normal power mode signal is received.

[7] 7. The liquid-filled lens driver according to claim 1, wherein the exchange of the lens driver control signal and the status information of the liquid-filled lens in the input/output interface unit is performed in such a way as to receive an effective data signal through a data signal wire by synchronizing with a clock signal transmitted through a clock signal wire.

[8] 8. The liquid-filled lens driver according to claim 1, wherein the exchange of the lens driver control signal and the status information of the liquid-filled lens in the input/output interface unit is performed in such a way as to set a register value in the input/output interface and read/write information from/in the register.

[9] 9. The liquid-filled lens driver according to claim 1, wherein the exchange of the lens driver control signal and the status information of the liquid-filled lens in the input/output interface unit is performed by selectively controlling each liquid-filled lens driver using a unique ID of the liquid-filled lens driver.

[10] 10. The liquid-filled lens driver according to claim 1, wherein the high voltage generation unit comprises:
a converter module for DC-converting voltage of the battery of the mobile information terminal into high DC voltage for driving the liquid-filled lens;
a voltage conversion clock generation module for generating a voltage conversion clock that is used for the DC voltage conversion in the converter module; and

a voltage conversion arresting module for stopping voltage conversion by stopping operation of the converter module when the voltage conversion is performed such that the high voltage generated in the converter module exceeds voltage for driving the liquid-filled lens (reference voltage).

[11] 11. The liquid-filled lens driver according to claim 10, wherein the high voltage generation unit further comprises:
a voltage division module for generating divided voltage lower than the high voltage by dividing the high voltage, which has been converted in the converter module, at a certain ratio; and
a voltage comparison module for comparing curvature reference voltage required for operating the liquid-filled lens with the divided voltage generated in the voltage division module, and providing an arresting signal to the voltage conversion arresting module when the divided voltage exceeds the curvature reference voltage.

[12] 12. The liquid-filled lens driver according to claim 1, wherein the reference/bias voltage generation unit comprises:
a reference/bias voltage provision module for providing reference and bias voltage to electronic elements of the liquid-filled lens driver; and
a curvature reference voltage generation module for providing curvature reference voltage to a voltage comparison module after generating analog voltage corresponding to a curvature value (drive voltage) of the liquid-filled lens transmitted from the image signal processor.

[13] 13. The liquid-filled lens driver according to claim 1, wherein the drive signal generation unit comprises:
a drive signal clock generation module for generating a drive clock in a waveform period of a signal for driving the liquid-filled lens;
a low voltage differential signal generation module for generating two low voltage differential signals having a voltage level of the battery of the mobile information terminal based on the drive clock; and
a high voltage differential signal generation module for generating plus and minus differential drive signals, that is, the final drive signal for the liquid-filled lens, by increasing a voltage amplitude of the low voltage differential signal to a level of the high voltage generated in the high voltage generation unit.

[14] 14. The liquid-filled lens driver according to claim 1, wherein the input/output interface unit, the system clock generation unit, the high voltage generation unit,

the reference/bias voltage generation unit, the drive signal generation unit, and the control unit are integrated in a single chip.

[15] 15. A high voltage generation circuit for generating high voltage to drive a liquid-filled lens, comprising:

a converter module for DC-converting voltage of a battery of a mobile information terminal into high voltage for driving the liquid-filled lens;

a voltage conversion clock generation module for generating a voltage conversion clock that is used for the DC voltage conversion in the converter module;

a voltage conversion arresting module for stopping voltage conversion by stopping operation of the converter module when the voltage conversion is performed such that the high voltage generated in the converter module exceeds voltage for driving the liquid-filled lens (reference voltage);

a voltage division module for generating divided voltage lower than the high voltage by dividing the high voltage, which has been converted in the converter module, at a certain ratio; and

a voltage comparison module for comparing curvature reference voltage required for operation of the liquid-filled lens with the divided voltage generated in the voltage division module, and providing an arresting signal to the voltage conversion arresting module when the divided voltage exceeds the curvature reference voltage;

wherein the voltage conversion clock generation module generates a plurality of clocks having various frequencies so that the converter module can selectively use a necessary voltage conversion clock; and

wherein the converter module variably selects and uses the plurality of clocks, which are generated from the voltage conversion clocks, according to characteristics of electric elements (such as, an inductor, a capacitor and a diode) of the corresponding

converter module.

[16] 16. The high voltage generation circuit according to claim 15, wherein the converter module comprises:

a discontinuous current mode DC-to-DC converter stage for causing current flowing through an inductor to be discontinuous;

an overcurrent detection stage for detecting overcurrent and generating an overcurrent detection signal when the overcurrent flows through the inductor and

a first transistor for performing voltage amplification conversion; and
an AND gate for generating a first transistor drive clock, which is a bias voltage signal, to the first transistor, by performing logical AND operation on the overcurrent detection signal received from the overcurrent detection stage and the voltage conversion clock generated in the voltage conversion clock generation module.

[17] 17. The high voltage generation circuit according to claim 16, wherein the overcurrent detection stage comprises:
a second transistor having a capacity of the first transistor divided by N (wherein N is an integer);
a constant current source for calculating allowable maximum current capable of flowing through the inductor and the first transistor of the DC-to-DC converter stage, and applying constant current corresponding to a value (that is, allowable maximum current/N) obtained by dividing the allowable maximum current by N; and
an overcurrent detection voltage comparator for comparing amplification voltage V1, which is generated when the first transistor of the DC-to-DC converter operates, with amplification voltage V2 of the second transistor, which is generated when the constant current generated in the constant current source flows, and generating an overcurrent detection signal when the V1 is higher than V2.

[18] 18. The high voltage generation circuit according to claim 17, wherein the constant current source receives an overcurrent detection control signal for variably controlling an amount of current from the control unit, and applies constant current corresponding to the consumed current and drive current of the liquid-filled lens.

[19] 19. The high voltage generation circuit according to claim 17, wherein the excessive current detection voltage comparator receives a control signal, and performs the comparison only when the first and second transistors operate.

[20] 20. A drive signal generation circuit for generating an output waveform to drive a liquid-filled lens, comprising:
a drive signal clock generation module for generating a drive clock in a waveform period of a signal for driving the liquid-filled lens;
a low voltage differential signal generation module for generating two low voltage differential signals having a voltage level of a battery of a mobile in-

formation terminal based on the drive clock; and

a high voltage differential signal generation module for generating plus and minus differential drive signals, which is the final drive signal for the liquid-filled lens, by increasing a voltage amplitude of the low voltage differential signal to a level of the high voltage generated in the high voltage generation unit.

[21] 21. The drive signal generation circuit according to claim 20, wherein the drive signal clock generation module generates a plurality of clocks having various frequencies so that the low voltage differential signal generation module can selectively use an optimal differential signal period for driving the liquid-filled lens.

[22] 22. The drive signal generation circuit according to claim 20, wherein the liquid-filled lens is driven in a differential signal manner by connecting one of the plus and minus drive signals, which are generated in the high voltage differential signal generation module, to a terminal of the liquid-filled lens and the other of the plus and minus drive signals to the other terminal of the liquid-filled lens.

[23] 23. The drive signal generation circuit according to claim 20, wherein the high voltage differential signal generation module comprises:

a voltage level converter for generating plus and minus drive signals, which is final drive signals, by voltage level-converting voltage of the low voltage drive signal generated in the low voltage differential signal generation module into high voltage level input from a converter module;

first and second buffers for buffering the plus and minus drive signals, which are generated in the voltage level converter, with respect to the liquid-filled lens; and

a slope adjusting resistor for keeping slopes of rising and falling times of the plus and minus drive signals uniform regardless of signal amplitude, respectively.